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A NEW PERMIAN *CIBOLOCRINUS* FROM BOLIVIA

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ABSTRACT

A flexible crinoid, *Cibolocrinus patriciae* sp. nov. from the Permian Copacabana Group of Bolivia is described. The holotype specimen was found at the original D'Orbigny collecting site near Yaurichambi, 10 km east of Lake Titicaca. The species is distinguished principally by the upflaring infrabasal plates, which are slightly convex, show impressed sutures, and are visible in lateral view of the dorsal cup. An inadunate crinoid from the same locality, previously described as *Delocrinus titicara* by Strimple and Moore, is here designated *Endelocrinus titicara* (Strimple and Moore, 1971) comb. nov.

INTRODUCTION

In 1969 Drs. Frank Stehli and James Helwig of Case Western Reserve University conducted a field study of Carboniferous and Permian strata of Bolivia. Mrs. Patricia Helwig accompanied the party as a representative of the Cleveland Museum of Natural History. The party visited the locality in the vicinity of Yaurichambi, 10 km east of Lake Titicaca, where D'Orbigny (1842) made the initial collection of Permian fossils from Bolivia. At that place Patricia Helwig collected fossil invertebrates from the Copacabana Group (Wolfcampian) and found a specimen of the flexible crinoid *Cibolocrinus* that proves to be a new species, which is described in the following pages. A paper by James Helwig (1972, map, fig. 1; Yaurichambi section, fig. 2) shows the location of Yaurichambi and a stratigraphic section taken at the collecting site.

Previously (1971) Strimple and Moore, in the first formal description of a crinoid from the Bolivian Permian, proposed the name

Delocrinus titicara for an inadunate crinoid that was also derived from the Copacabana Group at the Yaurichambi locality. However, their holotype specimen shows pits at the corners of the dorsal cup plates and the arms attain normal biseriality well above the summits of the primibrachs. These are diagnostic features of the genus *Endelocrinus* Moore and Plummer, 1940. In consequence I am herewith designating the taxon *Endelocrinus titicara* (Strimple and Moore, 1971) comb. nov. Further discussion of this species is reserved for a future publication.

Other references to Permian crinoids of Bolivia are few. Ahlfeld and Braniša (1960, p. 104) listed Icthyocrinidae indet., *Lecythiocrinus* cf. *olivaeformis** and *Delocrinus* sp. from the Copacabana Group at Lake Titicaca and Yaurichambi, and from the same beds at Zudáñez, *Delocrinus* sp. and *Aulocrinus?* sp. Of the latter, which is figured (ibid. pl. 7, fig. 20) Webster (1970) notes "(probably not an *Aulocrinus*)"; judging from the illustration, I take the specimen to be a cromyocrinid. In another publication Braniša (1965, pl. 54) illustrated additional crinoid material from the Copacabana, including *Lecythiocrinus* cf. *olliculaeformis* from Zudáñez (fig. 19), part of a biserial arm from Yaurichambi (fig. 43), and portions of crinoid stems (figs. 1-27), from Zudáñez, Apillipampa, Colquencha, and Yaurichambi.

ACKNOWLEDGMENTS

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*Evidently a *nomen nudum*

SYSTEMATIC PALEONTOLOGY

CLASS CRINOIDEA Miller, 1821

Family MESPILOCRINIDAE Jaekel, 1918

Genus CIBOLOCRINUS Weller, 1909

*Cibolocrinus patriciae** sp. nov.

Figs. 1-5

Diagnosis: Walls of dorsal cup outflaring from base, but more erect in region of radial circlet. Infrabasals visible in lateral view upflaring, and convex, with sutures between them impressed. Basals elongate, with sharply angular tips and straight distal borders.

Holotype: CMNH 3801, a mashed dorsal cup with complete B and C and damaged A and D IBrr₁; also damaged A and B IBrr₂.

Repository: Cleveland Museum of Natural History, Cleveland, Ohio.

Occurrence: Copacabana Group, Lower Permian (Wolfcampian).

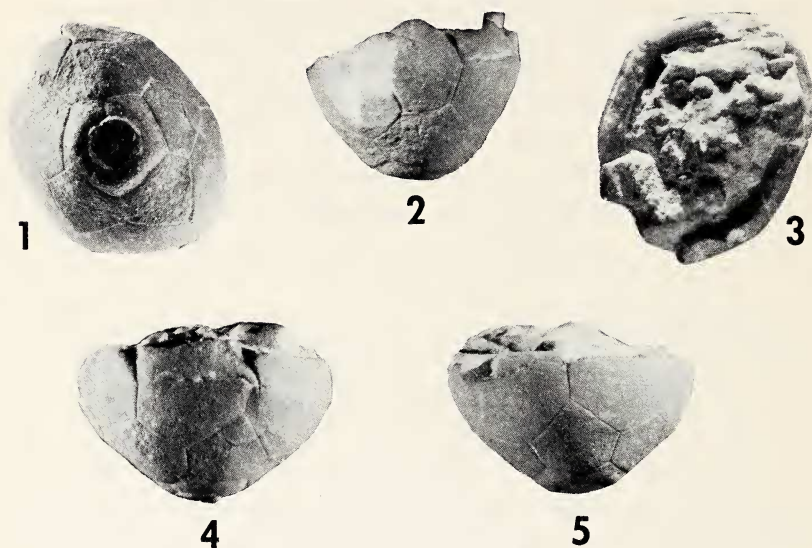
Locality: Hogback called "Cerro Vacha Kahtawi"; 3 km WNW of village of Yaurichambi and 10 km east of Lake Titicaca, just south of small church school (lat 40°17'56" S., long 68°29'10" W.) northern Bolivia.

Description: The dorsal cup is mashed and it is difficult to get a clear concept of its original proportions. The portion in the vicinity of the E ray seems to be the least distorted. Apparently the cup was low bowl shaped, and probably a little less than twice as wide as high. In lateral view the walls flare outward from the base, becoming steeper and more rounded a little above midheight. The posterior slope was evidently gentler than the anterior. In dorsal or ventral view the cup was probably pentagonal in outline.

The three infrabasals are clearly upflaring in lateral view of the cup. They are slightly but definitely convex, most so longitudinally, and a little indented along their common sutures. The A-ray plate is the smallest of the three. Part of the stem, showing a round lumen, is preserved. Its impression occupies nearly 3/5 of the diameter of the infrabasal circlet.

The five basals are slightly convex, with short interbasal sutures.

*The species is named for Patricia Helwig.



Figures 1-5. *Cibolocrinus patriciae* sp. nov. Holotype, CMNH 3801 from the Copacabana Group, Lower Permian, near Yaurichambi, Bolivia. Fig. 1, dorsal view; fig. 2, posterior view; fig. 3, ventral view; fig. 4, C-ray view (primanal at left); fig. 5, EA-interray view. X2

Their slopes are moderate. Except for the CD plate, each is hexagonal and extended distally, having a sharp tip. Their proximal angles are quite broad; that of the CD basal is least so. All of these plates are wider than long, including the CD basal, but the latter is the largest, with greatest distal extent. The CD basal is also heptagonal, being truncated distally where it meets the primanal plate.

The A, B, and E radials are about $3/5$, but the C and D radials are only slightly more than $1/2$, wider than long. The interrarial sutures are nearly as long as the interbasal sutures, but the radial-primanal sutures are half again as long. The radials are slightly convex longitudinally and transversely, but are more erect than the basals, and the cup walls are perceptibly steeper in the region of these plates. Interrarial notches are present at the summits of the radials. The articular surface of the E radial is exposed, revealing the typical

Cibolocrinus structure, with fan-shaped depressions at the lateral extremities and the surface contracted medially opposite the slitlike ligament pit.

The primanal is a large plate, nearly as long as the CD basal and a little more than half as wide. More than half its height is below the summits of the posterior radials. The plate is heptagonal; it has been damaged distally, but still shows four facets above the radials. Laterally it is notched in areas adjacent to the summit regions of the C and D first primibrachs.

Only portions of the A and D first primibrachs are preserved, and they show no details of the articular surfaces. The shattered E first primibrach was removed to expose the articular surface of the underlying radial. The C first primibrach is entire, and the adjacent B plate is essentially complete also. At midwidth these plates are about as long as the interrarial sutures, but they are longer laterally, where they project downward along the interrarial notches, although there is some distal increase also along the sides of the C plate, and the right side of the D plate shows marked elevation. The distal articular surface of the C first primibrach shows a slitlike external ligament pit, similar to that of the radial, but the lateral depressions are deeper and more basin-like than those of the radial. These plates bear notches that extend below their lateral summits (similar notches are found on the primanal, as noted above). Lateral extension of the second primibrachs extended downward along these notches.

Part of the articular surface of the left side of the B second primibrach is preserved; the lateral depression is similar to that of the first primibrach, although shallower. The remainder of this second primibrach is shattered and crushed. The adjacent A second primibrach is also too distorted by crushing to yield reliable data.

The cup surface appears finely granulose, but the ornament is not clearly distinguishable.

Measurements: Linear measurements, in mm, taken on holotype, CMNH 3801: Dorsal cup height, 8.5 (est.), width 16.0 (est.); H/W ratio, ca. 0.53; stem impression width, 3.9; infrabasal circlet width, 6.8; basal (EA) length, 5.4, width 5.8; radial (E) length, 4.9, width, 8.6; length suture between basals, 2.2; length suture between radials,

2.0; primanal height, 5.2 (appr.), width, 4.8.

Discussion: *Cibolocrinus patriciae* resembles certain Pennsylvanian representatives of the genus to the extent that its infrabasal plates are visible in lateral view of the dorsal cup. In the Morrowan *Cibolocrinus circulus* the lateral exposure of these plates is much less than in *C. patriciae*, and the cup outline has been described as “. . . subhemispherical when viewed from the side” (Moore and Strimple, 1973, p. 33). Although in its proximal half the cup of *C. patriciae* flares outward from the base, it is steeper walled and slightly rounded distally, thus differing from *C. circulus* and from the Missourian species *C. erectus* Strimple, 1951a and *C. conicus* Strimple, 1951b. In both of the latter forms the cup walls flare outward strongly from base to summit, and the dorsal cup has less height than that of *C. patriciae*, which in turn is surpassed in height by the cup of *C. circulus*. *Cibolocrinus patriciae* shows greater exposure of the infrabasal plates in lateral view than we find in Strimple's taxa, along with somewhat greater width of its infrabasal circle and slightly greater diameter of the stem impression. Among all four species, *C. patriciae* is unique in displaying convex infrabasals with impressed sutures. The elongate basals of *C. patriciae* compare to some extent with those of *C. circulus*, but in *C. circulus* the distal borders of the basals are curved, rather than straight. The interradianal notches noted by Strimple in *C. erectus* are present in *C. patriciae*; they are also apparently present in *C. conicus*, but seem to be absent in *C. circulus*, which would be consistent with Strimple's (1951a) observation of their absence in Morrowan forms.

In competition with species of *Cibolocrinus* having flat-based dorsal cups, these forms with upflared infrabasals may have had the advantage of offering less resistance to strong water currents, and thus might have survived under conditions where species with the more specialized type of cup could not. There is insufficient evidence to support the argument that species of *Cibolocrinus* showing upflared infrabasals are examples of regressive evolution. Already present in Lower Pennsylvanian time, species with infrabasals of this type probably occupied an environmental niche where this feature was an advantage, and they persisted into the Lower Permian with little further specialization.

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